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# Effect of hydrological connectivity on the molluscan community structure in oxbow lakes of the Łyna River

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**Key words:** Mollusca, oxbow lakes, the Łyna River, hydrological connectivity

## Abstract

During 2004 and 2005 research on the malacocenoses existing in oxbow lakes differ in terms of hydrological connectivity was conducted in the valley of the Łyna River. The results showed that the connection of an oxbow lake with the river is the key factor influencing the abundance and biomass of molluscs in the lake. Three types of oxbow lakes representing lentic, semi-lotic and lotic environments were considered. In the lentic oxbow lake Mollusca was dominated by *Potamapyrgus antipodarum* Gray, the semi-lotic by *Viviparus viviparus* L., and the lotic by *Pisidium* sp. The most hospitable conditions for the molluscs' development were found in the

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semi-lotic reservoir where contact with the river was maintained by backwater in the downstream arm. The separation of the reservoir from the river caused a total reduction of the Bivalvia representatives. Diversity of the malacocenoses resulted mainly from different abilities to adapt to temporary oxygen deficits. Each type of oxbow lake is characterized by an individual pattern of oxygen distribution. To avoid anaerobic conditions and enable the development of biodiversity in floodplains, water bodies should be supplied by well-aerated river water.

## INTRODUCTION

One of the natural features of rivers is their ability to change channel patterns. Channel changes are followed by a separation of some river sections, creating abandoned channels called oxbow lakes. Ward et al. (2002) distinguished a variety of lotic, semi-lotic and lentic water bodies occurring within river corridors whose permanence and succession relies on connectivity to the river. An essential role in the functioning of aquatic systems within or between elements of river floodplains is played by hydrological connectivity. The hydrological connectivity between the main course of a river and various water bodies lying in the alluvial floodplain influences biogeochemical fluxes, biodiversity and the food-web structure in these water bodies (Tockner et al. 1999). They are arranged along the middle course of rivers and, similar to various other components of the river landscape, often exchange water as well as dissolved and particulate matter through run-off and groundwater discharge phenomena.

During the passage through the oxbow lakes, these substances are involved in complex biogeochemical processes, which may lead to chemical transformations with important but negative consequences for the biodiversity in the ecosystems. In over-fertilized reservoirs, besides the massive development of phytoplankton, elimination of stenotopic organisms takes place. It concerns molluscs which are used as bioindicators of the environmental state (Kajak 1959). In spite of the lack of or limited contact with river water, oxbow lakes play a very important ecological role as a suitable place for the incubation of amphibians and ichthiofauna.

Given the climatic conditions of northern Poland the exchange of water between lentic water bodies lying in the alluvial floodplain and the river is limited to snow melting periods in spring (March-April) when floods occur. Except for the inundation periods, the isolation creates unfavorable conditions for the diversity of vertebrates' and invertebrates' development resulting mainly from a deficiency of oxygen (Obolewski et al. 2009). Intensive increase in fine sediments with high autochthonous organic matter content makes the bottom inhospitable for some bivalve species, but favorable for some gastropods.

While the presence of bivalves and gastropods in Polish oxbow lakes has been well recognized (Jezierska-Madziar et al. 2000; Obolewski 2005;

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Piechocki 2004; Stańczykowska 1959, 1960) and the significance of hydrology in determining the distribution of molluscs has been suggested by many authors (Reckendorfer et al. 2006, Tockner et al. 1999), detailed information on the effect of hydrology on the qualitative and quantitative structure of mollusc communities is still lacking.

This paper presents an analysis of the composition of molluscs' associations in a river-floodplain system based on the existence of individual species with respect to hydrological connectivity. The objectives of the study were:

- to compare the qualitative and quantitative structure of malacocenoses in three types of oxbow lakes in the middle section of the Łyna River in north-eastern Poland with respect to the lakes' hydrological connectivity and
- to provide information on the temporal variation in the abundance and biomass of mollusc associations in relation to the exchange of water between a reservoir and the river.

## MATERIALS AND METHODS

The Łyna River is one of the largest watercourses in north-eastern Poland, both in terms of length (264 km) and catchment area (7126 $km^2$). The meandering pattern of the channel takes 22.7% of the total river length. In the middle reach of the river, agricultural land use (grassland) prevails over forests. Along the study section (about 10 km.) the river is not supplied by any tributaries. The average river discharge is 14 $m^3 s^{-1}$, ranging from 7 $m^3 s^{-1}$ during low water periods up to 35 $m^3 s^{-1}$ during flood events. The riparian zone at the village of Smolajny, where the studied oxbow lakes are located, is directly flooded when the water discharge is over 22 $m^3 s^{-1}$. These floods have a recurrence period of 1.4 years calculated over a 40-year cycle (Glińska-Lewczuk 2005). However, the flooding usually takes place in the early spring months due to the snowmelt. Within the period of observation only two flood events were recorded: the first one lasted approximately 2 months and finished in mid-March 2004; the second one lasted 20 days and occurred in mid-February 2005.

The natural development of the alluvial floodplain of the Łyna River system, in the middle reach of the river, has been constrained by regulation that began in the mid1970s. Connectivity between abandoned channel loops and the active channel was maintained via an upstream arm. Floodplain water bodies of natural origin are partially intact and they are permanently isolated from the main river channel except for the periods of inundation.

The oxbow lakes located in the Łyna river valley are elongated and consist of a single loop inherited from the former river channel (Fig. 1). Their lengths

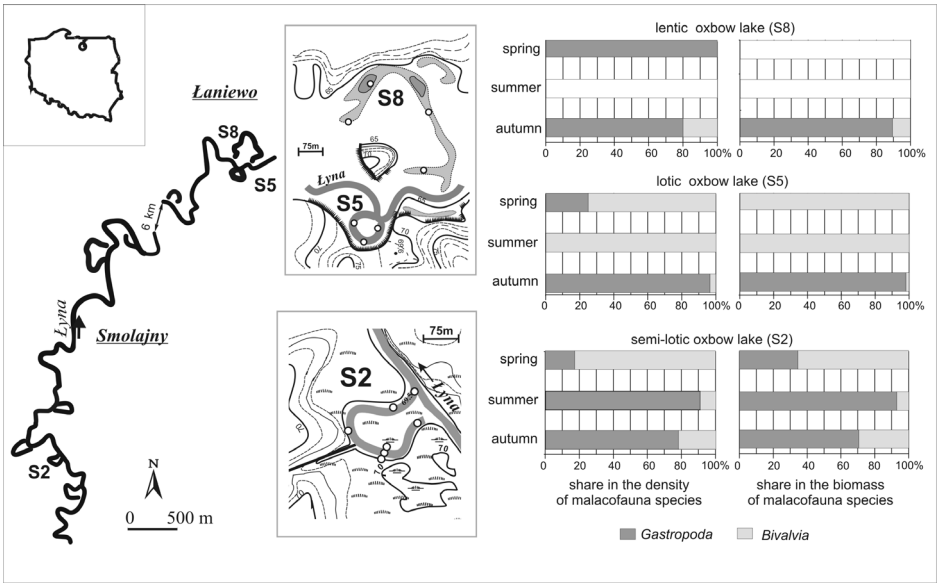



**Fig. 1.** Location of the studied oxbow lakes in the valley of the Łyna River.

are usually between 200 and 400 m. and average sinuosity is 3.0. Their water table areas are relatively small (ca. 1-2 ha.) and depths are below 2.5 m. (when referred to the river water table at 100 cm. on gauge). The water resources of oxbow lakes are heavily dependent on the river water table fluctuations, which amounted to 201 cm in the period of observation (Glińska-Lewczuk 2005).

The term "hydrological connectivity" follows the definition used by Reckensdorfer et al. (2006), who defined it as the average annual duration (days per year) of the upstream surface connection of floodplain water bodies with the main stem of the river. Based on the daily stages of the Łyna River at Smolajny gauge in the period of 1987-2005, we distinguished three different connectivity levels: isolated (lentic) reservoirs connected when the bank-full discharge is exceeded (0-30 days year$^{-1}$), semi-lotic reservoirs when the upstream arm is connected to the main river channel (31-250 days year$^{-1}$) and lotic reservoirs which are active in terms of flow due to connections at upstream and downstream arms and connected to the river by both arms over the period of 251-365 days year$^{-1}$. Among 60 reservoirs with permanent water tables in the river valley, the dominant habitat type (87%) is represented by lentic reservoirs disconnected from the river, while 10% are semi-lotic and 3% are lotic.

Material was taken from three oxbow lakes of different hydrological connectivity: S2 of semi-lotic character, S5 of lotic character, and S8 of lentic

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**Table 1**

Summary of morphology of the studied oxbow lakes and corresponding functional properties of oxbow lakes in the River Łyna valley according to Glińska-Lewczuk 2005.

| Parameter | | Oxbow lake | | |
|---|---|---|---|---|
| | | S5 | S2 | S8 |
| Hydrological connectivity | | Lotic<br>Upstream and downstream connections | Semi-lotic<br>Downstream connection | Lentic<br>Disconnected (Isolated) |
| Oxbow lake morphometry | Water table area♦, A (ha) | 0.92 | 0.31 | 1.58 |
| | Storage capacity♦, C ($10^3$ $m^3$) | 10.7 | 5.7 | 7.2 |
| | Elongation index, L/W | 20.4 | 15.7 | 28.5 |
| | Maximal depth, $D_{max}$ (m) | 2.6 | 2.3 | 1.4 |
| | Average covering aquatic plant (%) | 8.95 | 29.46 | 44.82 |
| Aquatic environment | Retention time | Short (0.5 – 7 days) | Long (12 – 40 days) | Very long (∞) |
| | Water transparency | Low | Moderate | High |
| | Trophic state | Mezotrophy, Eutrophy | Eutrophy, Hypertrophy | Hypertrophy |
| | Nutrient source | Allogenic | Autogenic or allogenic when river supply | Autogenic |
| | Average temperature | 10.7 | 13.0 | 13.2 |
| | Average pH | 7.08 | 7.27 | 7.70 |
| | TIN : TP | 1 : 1.5 | 1 : 2 | 1 : 0.2 |
| Bottom sediments | Bottom sediment (surface layer) | Mineral fine fractions, organic matter deposited at banks | Organic matter prevails in upstream arm | Thick organic layer built of detritus |
| | C : N : P | 1 : 15 : 556 | 1 : 13 : 54 | 1 : 10 : 28 |

♦ - referred to mean water level of the Łyna River at Smolajny gauge

character (Table 1). The sampling encompassed three zones in each reservoir: upstream and downstream arms as well as the middle part of a reservoir. Moreover, in S2 two other samples were collected - at the deepest place and at the junction of the downstream arm and the river channel (Fig. 1).

A total of 42 quantitative mollusc samples from bottom sediments were collected in summer and autumn 2004 and in spring 2005 using the Eckmann-Brige's sediment dredge with an average sediment sample volume of ca 4.5 $dm^{-3}$. Samples were taken in triplicates. The sediment was sieved through a 0.5 mm mesh net. All molluscs retained in the net were preserved in 4% formalin. Molluscs were identified to taxa and abundance refers to 1 $m^2$ of bottom area. The mollusc representatives were weighed using WPE-30 (±0.01 g) after drying on filter paper.

Biotic indices such as frequency (F%), domination index for abundance (D) and biomass ($D_m$) were used and interpreted according to the criteria given by Kasprzak and Niedbała (1981). The Shannon-Wiener biodiversity index was applied to the mollusc taxa and referred to each reservoir to make generalizations about the community responses to hydrological conditions. Assessment of statistical differences in abundance and biomass between the

malacocenoses representing three connectivity groups was calculated using the Cochran-Cox test at $P < 0.05$. Spearman's rank correlation coefficients and PCA analysis between the malacocenoses' biodiversity and categorized variables, such as season of the year, location of sampling sites, land use, and hydrologic connectivity, were performed using the *STATISTICA 7.1* software. Moreover, a Multivariate Regression Tree (MRT) analysis was performed to assess the effect of selected physico-chemical water parameters on the structure of malacocenoses. MRT analysis was carried out using the software R 2.0.0 (R Development core team 2004) and the package of mvpart (De'ath 2002). Crossvalidation with 2000 multi-crossvalidations was applied as well as the 1SE rule.

## RESULTS

A total of 12 aquatic mollusc taxa were found during the study period, 8 of which were gastropods and 3 of which were bivalves (Table 2). The highest number of malcacofauna representatives (8 taxa) characterized semi-lotic oxbow lake S2. However, the number changed over the seasons. The abundance of gastropods and bivalves was in balance and amounted to 359 ind. $m^{-2}$ on average. The share of gastropods in the average mollusc biomass in S2 accounted for 65% of the total (500 g w.w. $m^{-2}$). Relatively high frequency (F = 50%) was shown by *Viviparus viviparous* accompanied by bivalves of *Pisidium* sp. (F = 44%). We found that bivalves dominated over gastropods only in spring. Biomass of molluscs increasede successively from spring to autumn, but in summer its value was limited by *Viviparus viviparus,* while in autumn by *Pisidium* sp.

The lotic character of oxbow lake S5 was a convenient habitat for only 4 taxa: 2 gastropods and 2 bivalves. The abundance of molluscs amounted to 453 ind. $m^{-2}$ and biomass amounted to 313 g w.w. $m^{-2}$, on average. Gastropods, represented by *Viviparus viviparus* (eudominant) and *Lymnaea stagnalis* L. (subdominant), reached 68% of total abundance, whereas bivalves dominated in terms of biomass (60%). Optimal conditions for *Viviparus viviparus* development were found in autumn (F = 11%), whereas optimal conditions for *Lymnaea stagnalis* development were found in spring (F = 11%).

Representatives of gastropods preferring flowing water appeared to be sensitive to the low levels of water, high temperature and low transparency that appeared in summer. This intolerance resulted in a lack of gastropods among mollusc species in samples collected from the bottom of S5. Sites with high hydrological connectivity were favorable enough for bivalves, especially for *Pisidium* sp. and *Anodonta anatina* L.. They were relatively permanent inhabitants of the lotic water body with frequencies of 44% and 22%,

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**Table 2**

Average abundance A (ind. $m^{-2}$) and biomass B (gWW $m^{-2}$) of molluscs inhabiting bottom of oxbow lakes in the Łyna River valley.

| Taxon | S2 | | | | | | S5 | | | | | | S8 | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Spring | | Summer | | Autumn | | Spring | | Summer | | Autumn | | Spring | | Summer | | Autumn | |
| | A | B | A | B | A | B | A | B | A | B | A | B | A | B | A | B | A | B |
| **Gastropoda** | **189** | **19.4** | **211** | **576.7** | **149** | **375.1** | **119** | **0.9** | **0** | **0** | **830** | **375.1** | **95** | **1.5** | **0** | **0** | **104** | **25.0** |
| *Viviparus viviparus* L. | 30 | 13.2 | 148 | 548.7 | 149 | 375.1 | 0 | 0 | 0 | 0 | 830 | 375.1 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Valvata pulchella* Studer | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 15 | 18.4 |
| *Valvata piscinalis* Müller | 40 | 0.9 | 5 | 5.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 30 | 0.9 | 0 | 0 | 15 | 0.7 |
| *Planorbarius corneus* L. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 59 | 5.6 |
| *Segmentina nitida* Müller | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 15 | 0.3 |
| *Potamapyrgus antipodarum* Gray | 0 | 0 | 7 | 0.1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 65 | 0.6 | 0 | 0 | 0 | 0 |
| *Lymnaea stagnalis* L. | 119 | 5.3 | 30 | 1.6 | 0 | 0 | 119 | 0.9 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Lymnaea truncatula* Müller | 0 | 0 | 21 | 21.3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Bivalvia** | **416** | **19.7** | **59** | **46.8** | **52** | **460.6** | **356** | **514.7** | **0** | **0** | **30** | **7.0** | **0** | **0** | **0** | **0** | **0** | **0** |
| *Pisidium* sp. | 336 | 9.6 | 15 | 2.7 | 37 | 1.3 | 341 | 25.8 | 15 | 43.6 | 30 | 7.0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Sphaerium* sp. | 65 | 6.9 | 44 | 44.1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Anodonta anatina* L. | 14 | 2.0 | 0 | 0 | 15 | 459.3 | 13 | 365.3 | 8 | 20.5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Anodonata cygnea* L. | 1 | 1.2 | 0 | 0 | 0 | 0 | 2 | 123.6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Σ | 605 | 39.1 | 270 | 623.5 | 201 | 835.7 | 475 | 515.6 | 23 | 64.1 | 860 | 382.1 | 95 | 1.5 | 0 | 0 | 104 | 25 |
| SD | 93.9 | 4.4 | 40.7 | 151.0 | 41.6 | 157.6 | 97.1 | 135.2 | 4.4 | 12.1 | 229.6 | 103.9 | 19.2 | 0.3 | 0.0 | 0.0 | 16.7 | 5.2 |
| Shannon-Wiener index | 0.567 | | 0.607 | | 0.316 | | 0.301 | | 0.281 | | 0.066 | | 0.271 | | 0 | | 0.504 | |

respectively. Bivalves preferred well-aerated, although cold, water in spring that resulted in their highest abundance and biomass. In other seasons their numbers were reduced in oxbow lakes.

Habitat conditions of the isolated oxbow lake (S8) were inhospitable for the development of mollusc species, except for 4 gastropod taxa, characterized by very low abundance and biomass, 66 ind. $m^{-2}$ and 9 g w.w. $m^{-2}$, respectively. Species for which isolated sites were optimal enough, like *Valvata* sp., possessed a low connectivity tolerance and frequency of 11% (accidents). An exception was *Potamapyrgus antipodarum* preferring dynamic water, which was found in the isolated oxbow lake in spring, probably as a result of an inflow of flood water. Bivalves appeared to be totally intolerant of the conditions in the isolated oxbow lake, where temporary oxygen deficits occurred and light penetration was limited by floating macrophytes creating a widespread, compact cover. In summer, no gastropods were found there, either.

Data obtained on the molluscs' community structure showed statistical differences between groups of means in the studied oxbow lakes in the Cochran-Cox test at $P < 0.05$. However, no relationships between biodiversity of the malacocenoses and environmental variables (season, hydrological connectivity, location of sampling points and land use of the catchment) were stated using both R-Spearman correlation coefficients and PCA analysis.

The only regression tree analysis of MRT showed the significance of physico-chemical parameters of oxbow lake water, including aeration and temperature, and phosphorus concentrations (Fig. 2) on the structures of molluscan communities.The indicative species of the oxygen content beneath 6.76 mg $dm^{-3}$ and the phosphorus concentration beneath 4.04 mg $dm^{-3}$ (Fig. 2 - node 4) was *Viviparus viviparus*. *Pisidum* sp. dominated in the same conditions when the water temperature dropped down below 10.8°C.

## DISSCUSION

The ecology of the malacofauna species in oxbow lakes in the middle Łyna River valley appear to be largely in agreement with other available data (e.g. Reckendorfer at al. (2006)), which suggest that hydrological connectivity is the key factor influencing the biodiversity of floodplain water bodies. On the scale of the alluvial floodplain, this study confirms that the hydrological factor is important in structuring mollusc assemblages. Abiotic environmental factors are likely to have differential effects on the mollusc community structure and population dynamics.

The results showed that Mollusca are reliable indicators of freshwater habitats, even though temporal changes in the environment happen such as floods, changes in water temperature or oxygen deficiency. The common

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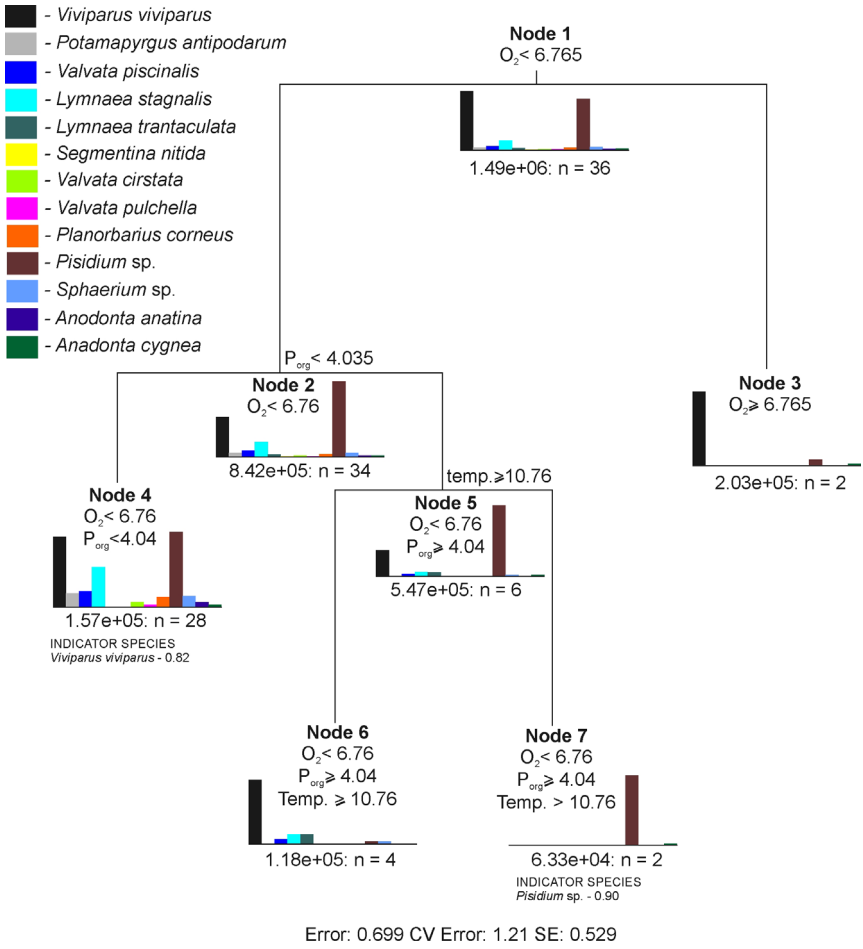



**Fig. 2.** MRT tree for average density (ind. $m^{-2}$) of particular taxa in relation to environmental condition.

representatives of mollusc species showed preferences for a wide range of aquatic conditions from stagnant to dynamic waters that can be colonized.

Hydrological connectivity between the main stem of the river and the associated floodplain water bodies has a major bearing on both diversity and distribution of species. The latter was indicated by the distinct connectivity optima and range of individual species, with species possessing the narrowest ranges (habitat specialists) found in completely lentic conditions. Similarl to the results obtained by Reckendorfer et al. (2006), the traits favored in these

habitats were oxygen and temperature tolerance, large body size and the ability to resist desiccation.

In the studied freshwater ecosystems, bivalve molluscs make up most of the biomass and even may exert control over the ecosystem structure and function (Strayer et al. 1999). These bivalves also can be important filter feeders and, in addition, can directly impact benthic processes as they burrow through sediments. Some freshwater bivalve species supplement suspension feeding in the water column by feeding on organic detritus and bacteria in the sediments, either through filtering interstitial water or by deposit feeding (McMahon 1991). Filtering interstitial water has been reported for *Sphaeridae* species including many species of *Pisidium* that filter and consume interstitial bacteria (Lopez and Holopainen 1987).

Side-arm connections are essential in understanding the relationship between hydrological connectivity and the requirements and performance of the biotic elements of the ecosystem. Among abiotic traits of the ecosystem, besides hydraulic conductivity and morphometry of a reservoir, water pollution is one of the main factors limiting the development of benthic fauna (Widerholm 1971). Type of water body, bottom sediment and the depth and transparency of the water column are of great significance for the development of mollusc species, too. Biotic traits of the ecosystem are based on the food-web structure. Thus, the abundance of macrozoobenthos is affected by predators' pressure on one hand, but on the other by the phytoplankton (Rasmussen and Kalff 1987) and detritus availability (Drake 1984).

The hydrological regime of the Łyna River limits water exchange between the main channel and the isolated oxbow lake to the period of floods in spring. That "deep breath" enhanced by well-aerated water from melting snow is a significant oxygen source until photosynthesis reaches the maximal level. Our results indicated that the long-term oxygen deficits in the lentic reservoirs cause the withdrawal of gastropods from the bottom onto the macrophytes such as pleustonic species or *Stratiotes aloides* L. (Obolewski 2005). Typical species inhabiting lentic ecosystems are pulmonates such as *Planorbarius corneus, Segmentina nitida* Müller or *Lymnaea stagnalis*, although the latter one colonized macrophytes, only. Their pulmonary respiration allows survival under low oxygen conditions when the detritus at the bottom assures the food. They have also a wider temperature tolerance than prosobranchs since shallow, lentic lakes have higher fluctuations of water temperature. This temporarily harsh environment with low oxygen content excludes most of the mollusc species, including all bivalves. The species found in lentic conditions are able to consume tougher material, such as dead macrophytes. On the other hand, they have a low ability to resist water current.

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In comparison with other studies on malacocenoses inhabiting oxbow lakes, the lentic ecosystem of the Łyna River (S8) showed the least density of the organisms – a density comparable to a dredged lentic oxbow in the valley of the Słupia River (Obolewski 2006). Limited inflow of "refreshing," well-aerated river water seems to be responsible for low values of Shannon indices, as confirmed by other research conducted in lentic oxbows in the Wisła (Starogrodzkie Płn.) and Słupia river valleys (Obolewski&Strzelczak 2008). The highest values of wet weight of the identified organisms are found in floodplain lakes of lotic character: like S2 and S5 in the Łyna River, Święconka oxbow in the Warta River or Osokowy Staw in the valley of the Słupia River (Gromadzińska-Graczyk 2005, Obolewski 2003). The lowest values of biomass were found in isolated ecosystems such as Starogrodzkie Płn. (Wisła River), Koński Staw (Słupia) or S8 (Łyna) (Obolewski&Glińska-Lewczuk 2008). The obtained results are evidence of the poor ecological status of the studied ecosystems which are in danger of intensive biogeochemical processes leading to the terrestrialization and finally disappearance of those valuable ecosystems.

Oxbow lakes of semi-lentic character are optimal for the development of consecutive mollusc generations. That is confirmed by the correlation between density and biomass. Our results confirm detailed studies conducted, for example, in the Danube floodplain by Tockner et al. (1999) or Reckendorfer et al. (2006) which found that mollusc species diversity increases at sites with intermediate connectivity to the main channel. Besides hydrological connectivity, both authors emphasized the importance of low velocities, and rare instances of oxygen depletion and dessication.

The mollusc population density in a lotic environment (S5) changed in the study periods in spite of a rare occurrence of oxygen depletion and relatively stable temperature. Free flowing water through the lake is responsible for gastropod species turnover (appearance/disappearance), mainly larvae. Bivalves maintained similar abundance and biomass that was conditioned by their burrowing style of life adapted to coarser sediment with a lower share of organic matter. The structure of the mollusc population can be significantly altered in interconnected water bodies as the predatory fish penetrate, which disadvantage large snails (Kajak 1966). The Łyna River system is abundant in fish preferring benthic food, with a domination of *Rutilus rutilus* L. (Terlecki et al. 2004), whose presence reduces mollusc abundance at places of low velocities of water.

During the study we found 12 mollusc taxa in the oxbow lakes, among 260 existing in Poland. Values of Shannon-Wiener biodiversity indices calculated for the oxbow lakes adjacent to the Łyna River ranging from 0.316 to 0.607 for a semi-lotic reservoir, 0.066 to 0.301 for a lotic and 0.000-0.504 for a lentic one were relatively low when compared to literature data (Gromadzińska-Graczyk

2005; Obolewski 2005, 2006). The low values of the biodiversity index of the oxbow lakes indicate the advanced processes of succession and terrestrialization which ultimately lead to decline in these habitats. Therefore, restoration strategies sustaining the diversity of entire habitats are urgently needed. A broad application of the hydrologic connectivity parameter, as defined and used in this paper, integrates many features of aquatic ecology of floodplain lakes. The use of the parameter in future floodplain management to encourage biodiversity restoration in river valleys is a promising practical tool.

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**CONCLUSIONS**

1. Aeration of water is the key factor influencing the structures of molluscan communities in oxbow lakes. A relatively stable and permanent source of oxygen for floodplain water bodies is the river water.
2. Oxbow lakes of semi-lotic character are optimal for the development of both gastropods and bivalves due to low velocities of water, rare oxygen depletion at the bottom, and infrequent desiccation as well as proper organic matter content in sediments. Isolated and lotic habitats hosted significantly fewer mollusc species.
3. Temporary oxygen depletion in lentic water bodies excludes most of the mollusc species, including all bivalves. Typical species inhabiting those ecosystems are pulmonates such as *Planorbarius corneus, Segmentina nitida* or *Lymnaea stagnalis.*
4. Hydrologic connectivity parameter integrates many features of aquatic ecology of floodplain lakes. It can be a promising practical tool in floodplain management for encouraging biodiversity restoration.

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